Privacy in *Privacy and Progress in Whole Genome Sequencing*

Contents

I. Introduction

In its report *Privacy and Progress in Whole Genome Sequencing* (*Privacy and Progress*), the Presidential Commission for the Study of Bioethical Issues (Bioethics Commission) highlights an important tension surrounding the advancement of the science of whole genome sequencing (i.e., determining the order of base pairs in an entire genome): how to reconcile the potential for important medical benefits to society at large with the privacy interests of individuals who choose to share their whole genome sequence data.[1] The report assesses the challenges that face the medical and research communities as whole genome sequencing technology becomes less expensive and more prevalent.

[1] Presidential Commission for the Study of Bioethical Issues (PCSBI). (2012, October). *Privacy and Progress in Whole Genome Sequencing*. Washington, DC: PCSBI.

II. Learning Objectives

Students should be able to:

1. Describe the privacy concerns related to whole genome sequencing.
2. Describe the ethical principles involved in reconciling privacy and progress in whole genome sequencing.
3. Describe the legal and policy considerations associated with protecting the privacy of individuals who contribute whole genome sequencing data and information.

III. Background

The unauthorized use or disclosure of medical information has long been a serious ethical concern.[2] *Privacy and Progress* considers this longstanding concern as it relates to the privacy issues that arise as a result of whole genome sequencing. Whole genome sequencing dramatically raises the stakes from even discrete genetic testing as it involves large amounts of biological and medical information that are inherently unique to a single person and has broad implications, both known and as yet unknown, for biological relatives.[3]

A. Whole Genome Sequencing

Whole genome sequencing is a process by which the complete sequence of an individual's DNA is determined.[4] Our whole genome sequence reveals our genetic blueprint, including observable traits, such as hair and eye color. Our genetic sequence also reveals predisposition to diseases, for example breast cancer or Alzheimer's disease.[5] In addition, whole genome sequence data can reveal variations in our DNA for which we do not yet understand the meaning.[6]

Importantly, whole genome sequencing reveals information about our biological relatives, including information that they might not know and perhaps might not want to know.[7] More than other types of medical information, whole genome sequencing reveals something fundamental about who we are, where we came from, and the health-related events that life might have in store for us.[8]

[2] PCSBI, (2012, October), op cit, p. 24.
[3] PCSBI, (2012, October), op cit, p. 24
[4] PCSBI, (2012, October), op cit, p. 16.
[5] PCSBI, (2012, October), op cit, p. 18.
[6] PCSBI, (2012, October), op cit, p. 18-19.
[7] PCSBI, (2012, October), op cit, p. 24.
[8] PCSBI, (2012, October), op cit, p. 24.

The process of whole genome sequencing is distinct from its precursor, discrete genetic testing. Genetic tests look for specific genetic variants in a particular part of the genome.[9] For example, a clinician who suspects that a patient has a particular disease with a known genetic cause, such as Huntington's disease, can order a genetic test that examines the specific gene of concern among the more than 20,000 genes in the human genome.[10] The result returned from discrete genetic tests is therefore much more targeted than the data generated in whole genome sequencing.

As recently as 2000, sequencing an entire human genome cost $2.5 billion.[11] This cost prohibited regular use of whole genome sequencing in research or clinical care. Over time, however, the cost of whole genome sequencing has dropped. Soon it could be less expensive to sequence an entire genome than to conduct a few genetic tests.[12] In the future, whole genomes could be routinely sequenced and stored in a patient's medical records to be used for the patient's future medical care.

B. Privacy

There is no consensus definition of "privacy." In *Privacy and Progress*, the Bioethics Commission considered privacy "broadly to mean states of affairs by virtue of which the accessibility of persons, personal information, or personal property is limited or restricted."[13] Confidentiality denotes restricting access to information to specifically authorized recipients (e.g., close family and friends or medical providers).[14] Anonymity denotes limiting access to personally identifiable information by intentionally disguising or removing identifiers.[15] Data

TERMINOLOGY

Whole genome sequencing: determining the order of nucleotide bases—As, Cs, Gs, and Ts—in an organism's entire DNA sequence

Whole genome sequence data: the file of As, Cs, Gs, and Ts that results from whole genome sequencing

Whole genome sequence information: facts derived from whole genome sequence data, such as predisposition to disease

Genomics: the study of all the DNA (the genome) in an individual, and how parts of the genome interact with each other and the environment

Genetic test: a discrete test that examines a specific genetic location or a single gene, such as the test for Huntington's disease

Genotyping: analyzing a handful to thousands of discrete variants across the genome (i.e., more than a discrete genetic test, but less than whole genome sequencing)

Source: Presidential Commission for the Study of Bioethical Issues (PCSBI). (2012, October). *Privacy and Progress in Whole Genome Sequencing*. Washington, DC: PCSBI, p.18.

[9] PCSBI, (2012, October), op cit, p. 19.
[10] PCSBI, (2012, October), op cit, p. 18.
[11] PCSBI, (2012, October), op cit, p. 22.
[12] PCSBI, (2012, October), op cit, p. 18.
[13] PCSBI, (2012, October), op cit, p. 38
[14] PCSBI, (2012, October), op cit, p. 39; Allen, A. (2011, Spring). Privacy and Medicine. In E.N. Zalta. (Ed.). *The Stanford Encyclopedia of Philosophy*. Retrieved October 29, 2014 from http://plato.stanford.edu/entries/privacy-medicine/.
[15] Ibid.

protection includes measures designed to prevent accidental or deliberate disclosures of confidential or anonymous information.[16]

In *Privacy and Progress*, the Bioethics Commission focused on informational privacy (i.e., limited access to information and data) and decisional privacy (i.e., the absence of interference with decisions about the collection, use, and sharing of genomic information) as they pertain to whole genome sequencing.[17] Concern for these privacy values includes the increasingly elusive ideal of control over the flow of information regarding oneself.[18]

The Bioethics Commission also recognized that, in some significant respects, an individual's genomic information is not and cannot be wholly private. Whenever we provide a blood sample in a clinical exam, or discard a coffee cup with traces of DNA on the lip in a public waste bin, we provide physical access to our genetic material.[19] Transforming that physical genomic specimen into whole genome sequence data and information is still a relatively costly and labor-intensive process, but might not always be so. Accordingly, it is important to ensure that adequate protections are in place to safeguard individuals' privacy.

C. Guiding Ethical Principles

In *Privacy and Progress*, the Bioethics Commission incorporated a number of ethical principles into its consideration of the privacy issues raised by whole genome sequencing.

The Bioethics Commission began its ethical analysis with the principle of respect for persons, a strong foundation for protecting individual privacy in the pursuit of public benefit.[20] Respect for persons recognizes that individuals are autonomous agents who are capable of deciding for themselves what they value, and how and when to act on those values.[21] Respect for persons requires giving great "weight to autonomous persons' considered opinions and choices while refraining from obstructing their actions unless they are clearly detrimental to others."[22] The misuse or unauthorized disclosure of an individual's whole genome sequence data against the individual's expressed or considered wishes violates the principle of respect for persons.[23]

[16] PCSBI, (2012, October), op cit, p. 39; Allen, A., op cit.
[17] PCSBI, (2012, October), op cit, p. 40.
[18] PCSBI, (2012, October), op cit, p. 43.
[19] PCSBI, (2012, October), op cit, p. 74.
[20] PCSBI, (2012, October), op cit, p. 34.
[21] PCSBI, (2012, October), op cit, p. 45.
[22] PCSBI, (2012, October), op cit, p. 45; National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1979). *The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research*. Washington, DC: Department of Health, Education, and Welfare, DHEW Publication OS 78-0012. Retrieved October 6, 2014 from http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.html.
[23] PCSBI, (2012, October), op cit, p. 45.

The principle of public beneficence requires both that public benefits be secured and that public harms be minimized.[24] Public beneficence gives rise to a societal and governmental duty to promote individual activities and institutional practices, such as scientific and biomedical research, that have great potential to improve the public's wellbeing.[25] There is a corresponding duty to minimize the societal and individual harms that can result from these scientific and technical advances.

The ethical principle of responsible stewardship calls for governments and societies to proceed prudently in promoting science and technology that can improve human welfare but can also cause harm, and to recognize the importance of citizens and their representatives acting collectively for the betterment of all, especially those who cannot represent themselves.[26] The principle also calls for governments and societies to proceed prudently in promoting scientific advancement by taking into account the interests and needs of those unable to represent themselves.[27] Groups requiring additional protection can include children, individuals with impaired capacity to consent, or individuals who might be unaware of risks of sharing whole genome sequence data and information.

A fourth principle that the Bioethics Commission considered in *Privacy and Progress* was intellectual freedom and responsibility. Intellectual freedom grants scientists, acting responsibly, the right to use their creative abilities to advance science and the public good. Intellectual responsibility calls on scientists to adhere to the ethical ideals of research. These ideals include avoiding harm to others and abiding by applicable policies, rules, and regulations.[28] As a corollary, the Bioethics Commission endorses the principle of regulatory parsimony, which calls for "only as much oversight as is truly necessary to ensure justice, fairness, security, and safety while pursing the public good."[29]

Democratic deliberation, an approach to collaborative decision making, embraces respectful debate of opposing views and active participation by citizens. "Democratic deliberation warrants engaging the public and fostering dialogue among the scientific community, policy makers, and persons concerned with the issues raised by scientific progress."[30]

Finally, the principle of justice and fairness relates to the distribution of benefits and burdens across society. The Bioethics Commission recognized the importance of "ensuring that the unavoidable burdens of technological advances do not fall disproportionately on any particular

[24] PCSBI, (2012, October), op cit, p. 36.
[25] PCSBI, (2012, October), op cit, p. 35.
[26] PCSBI, (2010, December). *New Directions: The Ethics of Synthetic Biology and Emerging Technologies*. Washington, DC: PCSBI, p. 25.
[27] PCSBI, (2012, October), op cit, p. 29.
[28] PCSBI, (2012, October), op cit, p. 29.
[29] PCSBI, (2012, October), op cit, p. 29.
[30] PCSBI, (2012, October), op cit, p. 30.

individual or group, and that the benefits are widely and equitably distributed."[31] In accordance with this principle, the numerous scientific advances stemming from investments in science and medicine should be made accessible to the broadest possible number of persons and the burden should not fall on a limited group of individuals.[32]

D. The Tension Between Privacy and Progress

Whole genome sequencing holds out the promise of medical advances that could benefit all of society. Whole genome sequence data, together with related information, enables scientists to make connections between variations in whole genome sequence data and specific diseases. Making these connections, however, requires large amounts of whole genome sequence data and health and demographic information to assess which genetic variants are correlated with particular phenotypic outcomes.[33] Continued advances therefore depend on large numbers of individuals who are willing to share their whole genome sequence data and information.[34]

Transmitting additional information along with whole genome sequence data, however, might make it easier to identify an individual and connect that individual's whole genome sequence to their private health information.[35] Accordingly, while society stands to benefit from advances brought about by whole genome sequencing, the privacy risks associated with sharing whole genome sequence data fall predominantly on individuals.[36] Reconciling the goals of promoting medical progress while protecting individual privacy means addressing the competing concerns of ensuring confidentiality of whole genome sequence data, granting appropriate access to and use of these data, and empowering participants who want to share their data without weakening privacy protections for others.[37]

E. Policy and Governance

As a legal matter, the word "privacy" does not appear in the U.S. Constitution. Nevertheless, the Bill of Rights implicitly recognizes the value and rights of privacy through provisions guaranteeing: 1) freedom of speech; freedom of religious, political, and personal association; and related forms of anonymity (First Amendment); 2) freedom from government appropriation of one's home (Third Amendment); 3) freedom from unreasonable search and seizure of one's body and property (Fourth Amendment); 4) freedom from compulsory self-incrimination (Fifth Amendment); 5) freedom from cruel and unusual punishment, including unnecessarily extreme deprivations of privacy (Eighth Amendment); and 6) other personal freedoms (Ninth Amendment). The Supreme Court and state courts also have used the Fourteenth Amendment's

[31] PCSBI, (2012, October), op cit, p. 30.
[32] PCSBI, (2012, October), op cit, p. 30.
[33] PCSBI, (2012, October), op cit, p. 16.
[34] PCSBI, (2012, October), op cit, p. 16.
[35] PCSBI, (2012, October), op cit, p. 16.
[36] PCSBI, (2012, October), op cit, p. 16.
[37] PCSBI, (2012, October), op cit, p. 31.

due process clause and language of liberty to strike down laws interfering with autonomous medical, marital, sexual, and family decision making.[38]

Federal law provides additional and specific statutory protection for genetic information. The Genetic Information Nondiscrimination Act of 2008 (GINA) prohibits genetic discrimination in the health insurance and employment contexts. GINA does not, however, regulate access, security, and disclosure of genetic or whole genome sequence data and information, nor does it protect against discrimination in other contexts. A number of U.S. states have laws on genetic information, but they vary greatly in their protections of individuals.[39] As a result, the patchwork of state and federal laws does not provide uniform protection of genomic data privacy.[40]

The Bioethics Commission's approach to whole genome sequencing protections was to recognize three facets of privacy and confidentiality protections. The first facet requires fostering ethical behavioral norms among individual researchers and clinicians. The second facet involves information technology, using technological protections to ensure that participant and patient whole genome sequence data and information are secure. The third facet is policy, requiring that systems provide training and preparation to handle whole genome sequence data and information, an atmosphere of trust, an expectation of security, and recourse should individual and information technology privacy protections fail.

F. Bioethics Commission Recommendations

Of the twelve recommendations the Bioethics Commission made in *Privacy and Progress*, five address privacy directly.

The first two assert that privacy protections should guard against unauthorized access to, and illegitimate uses of, whole genome sequence data and information while allowing for authorized users of these data to advance individual and public health.

> **Recommendation 1.1**
>
> **Funders of whole genome sequencing research; managers of research, clinical, and commercial databases; and policy makers should maintain or establish clear policies defining acceptable access to and permissible uses of whole genome sequence data. These policies should promote opportunities for models of data sharing by individuals who want to share their whole genome sequence data with clinicians, researchers, or others.[41]**

[38] PCSBI, (2012, October), op cit, p. 37.
[39] PCSBI, (2012, October), op cit, p. 27.
[40] PCSBI, (2012, October), op cit, p. 52.
[41] PCSBI, (2012, October), op cit, p. 5.

Recommendation 1.2

The Commission urges federal and state governments to ensure a consistent floor of privacy protections covering whole genome sequence data regardless of how they were obtained. These policies should protect individual privacy by prohibiting unauthorized whole genome sequencing without the consent of the individual from whom the sample came.[42]

The remaining recommendations address the fact that data privacy requires data security. Data security requires ethical responsibility and accountability from all those who handle whole genome sequence data.

Recommendation 2.1

Funders of whole genome sequencing research; managers of research, clinical, and commercial databases; and policy makers should ensure the security of whole genome sequence data. All persons who work with whole genome sequence data, whether in clinical or research settings, public or private, must be: 1) guided by professional ethical standards related to the privacy and confidentiality of whole genome sequence data and not intentionally, recklessly, or negligently access or misuse these data; and 2) held accountable to state and federal laws and regulations that require specific remedial or penal measures in the case of lapses in whole genome sequence data security, such as breaches due to the loss of portable data storage devices or hacking.[43]

Recommendation 2.2

Funders of whole genome sequencing research; managers of research, clinical, and commercial databases; and policy makers must outline to donors or suppliers of specimens acceptable access to and permissible use of identifiable whole genome sequence data. Accessible whole genome sequence data should be stripped of traditional identifiers whenever possible to inhibit recognition or re-identification. Only in exceptional circumstances should entities such as law enforcement or defense and security have access to biospecimens or whole genome sequence data for non health-related purposes without consent.[44]

[42] PCSBI, (2012, October), op cit, p. 5.
[43] PCSBI, (2012, October), op cit, p. 6.
[44] PCSBI, (2012, October), op cit, p. 6.

Recommendation 2.3

Relevant federal agencies should continue to invest in initiatives to ensure that third-party entrustment of whole genome sequence data, particularly when these data are interpreted to generate health-related information, complies with relevant regulatory schemes such as the Health Insurance Portability and Accountability Act and other data privacy and security requirements. Best practices for keeping data secure should be shared across the industry to create a solid foundation of knowledge upon which to maximize public trust.[45]

IV. Reading

For the purposes of discussion, students should download and read the following Bioethics Commission materials (reports are available for download on the Bioethics Commission's website at www.bioethics.gov under "Projects"):

Privacy and Progress in Whole Genome Sequencing, pp. 13-50 ("Introduction" and "Chapter 1: Ethical Principles").

V. Discussion Questions

The following questions are based on the information provided above and through the indicated reading and are intended to reinforce important aspects of privacy in whole genome sequencing that are highlighted in *Privacy and Progress*. Important points are noted with each question to help the instructor guide group discussion. The "Additional Resources" section is a helpful source in answering these questions.

1. **What does the umbrella term of "privacy" include as it relates to whole genome sequencing?**

   Starting points for discussion:

   a. In the United States and many other societies, health information is widely considered personal, sensitive, or intimate, and genetic information especially so.

   b. In the context of whole genome sequencing, data must be kept confidential; databases must be secure, and information must not be divulged to unauthorized users.

[45] PCSBI, (2012, October), op cit, p. 7.

c. A health record or whole genome sequence information can be de-identified by removing the 18 HIPAA identifiers, including a patient's name, address, and social security number.

d. Whole genome sequence data that are electronically stored or transmitted can be protected with computer passwords and encryption. Ethical norms, along with research and business practices, can and should protect data from unauthorized access, use, and disclosure.

e. Informational privacy refers to the limited access to genetic information and data.

f. Decisional privacy refers to the absence of interference with decisions about the collection, use, and sharing of genetic information.

2. What ethical principles did the Bioethics Commission incorporate into its consideration of the privacy issues raised by whole genome sequencing?

Starting points for discussion:

a. Respect for persons, which recognizes that individuals are autonomous agents, calls for the appropriate use and disclosure of an individual's whole genome sequence data and information.

b. Public beneficence gives rise to a societal and governmental duty to promote individual activities and institutional practices that have potential to improve the public's wellbeing while minimizing personal and public harms.

c. Responsible stewardship calls for governments and societies to proceed prudently in promoting science and technology that can improve human welfare but can also cause harm, and to recognize the importance of citizens and their representatives acting collectively for the betterment of all, especially those who cannot represent themselves.

d. Intellectual freedom and responsibility grants scientists, acting responsibly, the right to use their creative abilities to advance science and the public good and calls upon scientists to adhere to the ideals of research.

e. Regulatory parsimony calls for the fewest regulations necessary to ensure justice, fairness, security, and safety.

f. Democratic deliberation is a collaborative decision making process that warrants engaging the public and fostering dialogue among the scientific community, policy makers, and persons concerned with the issues raised by scientific progress.

g. Justice and fairness establishes that the unavoidable burdens of technological advances do not fall disproportionately on any particular individual or group, and that the benefits be widely and equitably distributed.

3. What are the three facets of privacy and confidentiality protections recognized by the Bioethics Commission?

Starting points for discussion:

a. Fostering ethical behavioral norms among individual researchers and clinicians.

b. Ensuring that participant and patient whole genome sequence data and information are secure.

c. Requiring that systems provide training and preparation to handle whole genome sequence data and information, an atmosphere of trust and an expectation of security, and recourse should individual and information technology privacy protections fail.

4. Why is privacy of particular concern with whole genome sequencing?

Starting points for discussion:

a. Whole genome sequencing involves large amounts of biological and medical information that are inherently unique to a single person and has broad implications, both known and as yet unknown, for biological relatives.

5. In the case of *Beleno v. Texas Department of State Health Services* parents sued, claiming that the Texas Department of State Health Services collected and stored newborn blood samples, subsequently making them available for research purposes, without seeking parental consent. How do the Bioethics Commission's ethical principles apply to this scenario?

Starting points for discussion:

a. Respect for persons recognizes that individuals are autonomous agents who are capable of deciding for themselves what they value, and how and when to act on those values. In this scenario, consider whether the Texas Department of State Health Services exhibited respect for persons when it collected and stored newborn blood samples without the families' consent.

b. Public beneficence calls for the promotion of benefits to society more broadly. Use of the newborn blood samples by public health officials can foster public benefit by advancing research in genetic disorders that can have serious health consequences.

VI. Problem-Based Learning

Scenario A. *An artist collects strands of hair, chewing gum, and cigarette butts she finds on the street, sequences the DNA found on these specimens, and creates portrait sculptures based on the DNA profiles.*

The following additional reading might be useful in considering this scenario:

> Angley, N. (2013, September 4). Artist creates faces from DNA left in public. *CNN*. Retrieved August 15, 2014 from http://www.cnn.com/2013/09/04/tech/innovation/dna-face-sculptures/.

1. **What information about an individual can the artist glean from a person's DNA? What information is impossible to determine?**

   Starting points for discussion:

   a. The artist can learn about many characteristics of the individual, including ancestral history, sex, eye and hair color, skin complexion, facial feature dimensions, and their tendency to be overweight, among others.

   b. The artist cannot know other things about the individual, such as age, education, work history, medical history, or exact facial structure, among others.

2. **How do the Bioethics Commission's ethical principles apply to this scenario?**

   Starting points for discussion:

   a. Respect for persons recognizes that individuals are autonomous agents who are capable of deciding for themselves what they value, and how and when to act on those values. In this scenario, consider whether the artist exhibited respect for persons when she tested the individuals' DNA.

   b. Public beneficence requires both that public benefits be secured and that public harms be minimized. In this scenario, consider how best to reconcile the public benefit of the art with the potential harms to the unidentified and currently unidentifiable individuals who had their DNA sequenced without their consent. If

the artist collects predominantly from one ethnic population, the work could cause harm through the propagation of stereotypes, for example.

3. As a result of the variation in state laws, there is no standard or comprehensive approach for protecting genetic information in the United States. How does the level of protection afforded to an individual's genetic information differ between Maryland and Nevada?

The following additional reading from *Privacy and Progress* provides useful information:

Privacy and Progress, pp. 121-124 ("Appendix IV: U.S. State Genetic Laws").

Starting points for discussion:

a. Nevada requires consent to perform, obtain, retain, and disclose genetic information. This applies to insurance companies, healthcare providers, government entities, and all businesses.

b. Maryland has no law to protect individual genetic information.

c. Responsible stewardship calls for governments and societies to proceed prudently in promoting scientific advancement by taking into account the interests and needs of those unable to represent themselves. In this scenario, consider whether state laws adequately protect the interests of those whose DNA is sequenced.

4. What are some practical considerations that this scenario raises?

Starting points for discussion:

a. Surreptitious genetic testing might diminish individuals' trust of legitimate research endeavors. If individuals are less inclined to participate in research, it could hamper potentially beneficial research.

b. It is impossible to limit physical access to all sources of genomic data. Whenever we provide a blood sample in a clinical exam, or discard a coffee cup with traces of DNA on the rim in a public waste bin, for example, we provide physical access to our genetic material.

5. What privacy safeguards, if any, protect individuals whose DNA is obtained surreptitiously?

Starting points for discussion:

a. GINA made it illegal for employers and health insurance providers to discriminate based on genetic information. GINA does not, however, regulate access, security, and disclosure of genetic or whole genome sequence information, nor does it protect against discrimination in other contexts.

b. State laws vary widely in the protections afforded to their citizens regarding the collection and use of genetic data. Only about half of all states, for example, offer explicit protections against surreptitious commercial genetic testing.

c. Whether non-consensual genetic testing or whole genome sequencing is prohibited by state law depends on a number of factors: who conducts the test, to whom the DNA belongs, what the test attempts to determine, how the results will be used, and where the testing takes place. No states have laws or regulations specific to whole genome sequence data separate and apart from genetic data.

Scenario B. *UK Biobank, a registered charity and a recipient of government funding, is a long term study in the United Kingdom designed to investigate the role of genetic, environmental, and lifestyle factors in the causes of diseases in the middle-aged and elderly. UK Biobank collected blood, urine, and saliva samples from over 500,000 research participants. Its Frequently Asked Questions (FAQs) webpage addresses the privacy-related concerns of its research participants.*

Go to UK Biobank's FAQ page:

> UK Biobank. (n.d.). FAQs [Webpage]. Retrieved October 6, 2014 from http://www.ukbiobank.ac.uk/all-faqs/.

Read the following sections on this page:

- *Will access be allowed for purposes other than health-related research?*
- *Why might participants be re-contacted?*
- *How will information about participants be kept safe?*
- *Withdrawal from UK Biobank*

1. **How does the management of this biobank reconcile individual privacy and scientific progress?**

   Starting points for discussion:

   a. UK Biobank is a resource for scientists to conduct "health-related research that is in the public interest." Applications for access to biobank materials will be denied to insurance companies and employers. UK Biobank will only release information to law enforcement agencies following a court order.

   b. UK Biobank assures that every consenting research participant's personal information will be kept confidential and secure. Researchers are provided with de-identified information and agree not to attempt to re-identify participants. Additional identity-protecting measures are taken for individuals with rare illnesses.

2. **What is UK Biobank's procedure for using research participants' information and samples for new studies?**

   Starting points for discussion:

   a. The informed consent process indicates whether researchers can re-contact research participants regarding participation in a study that requires new information.

   b. Re-consent must be obtained for any new use of a research participant's information and/or samples that did not fall under the existing consent.

   c. To protect participants' identities, researchers do not contact research participants directly. UK Biobank makes contact of behalf of all researchers.

   d. Re-contact requires ethics approval and advice from UK Biobank's Ethics & Governance council.

3. **What ongoing rights do individuals retain with regard to their biological samples?**

   Starting points for discussion:

   a. Research participants can contact UK Biobank to withdraw from a study at any time.

   b. Participants can choose to allow current use of their information and samples and future use of their health records, but can request that they not be re-contacted in the future.

c. Participants also can choose to restrict access to health records in the future.

d. Participants can opt to restrict all future use of their information and samples. In this case, UK Biobank would destroy all of that individual's samples and maintain information for archival purposes only (i.e., the information would not be used in new research going forward, but it also could not be removed from research that had already taken place).

VII. Exercises

Exercise A. *In 1951, Henrietta Lacks went to her doctor to undergo a cervical cancer biopsy. Without her knowledge, cells from that sample were cultured and used for research. Today, the immortal HeLa cell line is one of the most widely used and productive cell lines in biomedical research. The cells contain the genomic information of Henrietta Lacks and her biological family members. Although the HeLa cell line has been used in research for over 60 years, it was not until 2013 that researchers first published the HeLa genome sequence. In August 2013, after the genome had been taken down from the public domain, the Lacks family endorsed case-by-case release of her genomic data.*

The following references provide a summary of recent events and privacy concerns of the Lacks family:

Skloot, R. (2013, March 23). The immortal life of Henrietta Lacks, the sequel. *The New York Times*. Retrieved October 6, 2014 from http://www.nytimes.com/2013/03/24/opinion/sunday/the-immortal-life-of-henrietta-lacks-the-sequel.html?pagewanted=all.

Callaway, E. (2013, August 8). Deal done over HeLa cell line. *Nature*, 500(7461), 132-133. Retrieved October 6, 2014 from http://www.nature.com/news/deal-done-over-hela-cell-line-1.13511.

The following reference provides additional useful information:

Presidential Commission for the Study of Bioethical Issues (PCSBI). (2013, September). *Informed Consent Background*. Washington, DC: PCSBI. Retrieved October 6, 2014 from http://bioethics.gov/node/2866.

1. **What were the concerns of the Lacks family when scientists published Henrietta Lacks' genomic data?**

2. **What safeguards, if any, are in place to protect the Lacks family from discrimination based on their genetic information? Are these safeguards sufficient?**

3. **How does the agreement between the Lacks family and the National Institutes of Health (NIH) strike the balance between protecting the privacy rights of the Lacks family and supporting scientific research?**

Exercise B. *The NIH's Policy for Sharing of Data Obtained in NIH Supported or Conducted Genome-Wide Association Studies (GWAS), released in 2007, addresses the privacy of research participants involved in NIH-funded genome-wide association studies. NIH defines a genome-wide association study as "any study of genetic variation across the entire human genome that is designed to identify genetic associations with observable traits (such as blood pressure or weight), or the presence or absence of a disease or condition."*[46]

The following reference leads to the NIH policy:

> NIH. (2007). Policy for Sharing of Data Obtained in NIH Supported or Conducted Genome-Wide Association Studies (GWAS) [Webpage]. Retrieved October 6, 2014 from http://grants.nih.gov/grants/guide/notice-files/NOT-OD-07-088.html.

1. **How does the NIH policy protect the privacy interests of research participants?**

2. **In 2009, the NIH announced that it would extend the Genome-Wide Association Studies policy to encompass a wider range of genomic research. The NIH posted a Genomic Data Sharing policy on August 26, 2014. What individual privacy considerations, if any, does the Genomic Data Sharing policy address that the previous Genome-wide Association Studies policy does not?**

The following references provide useful information:

> Final NIH Genomic Data Sharing Policy, 79 Fed. Reg. 51,345, 51,354 (Aug. 28, 2014). Retrieved October 6, 2014 https://www.federalregister.gov/articles/2014/08/28/2014-20385/final-nih-genomic-data-sharing-policy.
>
> NIH. (2014). NIH Issues Finalized Policy on Genomic Data Sharing [Press release]. Retrieved October 6, 2014 from http://www.nih.gov/news/health/aug2014/od-27.htm.

[46] NIH. (2007). Policy for Sharing of Data Obtained in NIH Supported or Conducted Genome-Wide Association Studies (GWAS) [Webpage]. Retrieved August 15, 2014 from http://grants.nih.gov/grants/guide/notice-files/NOT-OD-07-088.html.

VIII. Glossary of Terms

Anonymized data: Data from which a patient's identifiers have been permanently removed and no link remains between the individual and his or her data.

Autonomy: The capacity to direct the course of one's own life or to live according to one's own values and beliefs.

Biobank (biorepository): A stored collection of physical biological samples (e.g., blood or tissue); some biobanks also store associated data (e.g., medical information).

Confidentiality: A set of rules or a promise to restrict access to certain information.

De-identified data: Data that have been separated from information identifying the individual from which they were derived. Importantly, a "key" or code connecting the two might still exist, but researchers are not allowed to access the key.

Democratic deliberation: An approach to collective and collaborative decision making that seeks to clarify and articulate factual and ethical issues at the core of a debate, to create consensus whenever possible, and to map the terrain of disagreements in a respectful way—when agreement is not immediately attainable—by encouraging reciprocity, respect for persons, transparency, publicity, and accountability.

Distributive justice: An ethical principle that calls for equitable distribution of benefits and burdens across society—for example, the benefits and burdens of biomedical research, or of technological advances.

Informed consent: The process of informing and obtaining permission from an individual before conducting medical or research procedures or tests.

Intellectual freedom and responsibility: The notion that scientists and other researchers, acting responsibly, should use their creative abilities to advance science and the public good while adhering to the ideals of research, avoiding harm to others, and abiding by all associated rules.

Large-scale genetic sequencing: The ordering of the billions of base pairs—the As, Ts, Cs, and Gs—that make up our genetic code (e.g., whole genome sequencing, whole exome sequencing, and other next-generation genomic analyses).

Public beneficence: An ethical principle that encourages us to pursue and secure public benefits while minimizing personal and public harm.

Respect for persons: Ethical principle requiring that individuals are treated as independent and self-determining (autonomous) agents and that persons with diminished autonomy are entitled to additional protections.

Responsible stewardship: Ethical principle requiring governments and scientists to proceed prudently in promoting science and technology that can improve human welfare but can also cause harm, and to recognize the importance of citizens and their representatives acting collectively for the betterment of all, especially those who cannot represent themselves.

Whole genome sequencing: Determining the order of nucleotide bases—As, Ts, Gs, and Cs—in an individual's entire DNA sequence.

IX. Additional Resources

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